PS-2.1 Compare the subatomic particles (protons, neutrons, electrons) of an atom with regard to mass, location, and charge, and explain how these particles affect the properties of an atom (including identity, mass, volume, and reactivity).

Taxonomy Level: 2.6-B Understand/Compare Conceptual Knowledge
2.7-B Understand/Explain Conceptual Knowledge

Supporting Content Websites

jlab.org
http://education.jlab.org/atomtour/index.html
Website is a good interactive tour of the atom including protons, neutrons, and electrons and their masses and charges.
P.S.-2.1

jlab.org
http://education.jlab.org/elementmath/index.html
This game chooses an element randomly and asks the student to provide the number of protons, neutrons, or electrons from the information given.
P.S.-2.1 and P.S.-2.4

Colorado.edu
http://www.colorado.edu/physics/2000/isotopes/index.html
Good explanations of both stable and unstable isotopes.
P.S.-2.2

Schoolscience.com
http://www.schoolscience.co.uk/content/4/physics/atoms/partch5pg1.html
Site has good detail using lithium. It includes a question for students to work through.
P.S.-2.2

Chem4kids.com
http://www.chem4kids.com/files/elem_pertable.html
There a good descriptions of the periodic table and trends. The language used is easy for students to understand.
P.S.-2.3

Chemicalelements.com
http://www.chemicalelements.com
This is an interactive periodic table that displays information on elements as students click on them.
P.S.-2.3

jlab.org
http://education.jlab.org/qa/pen_number.html
This is a good demonstration of how to calculate number of protons and electrons for a given element.
P.S.-2.4

Chem4kids.com
http://www.chem4kids.com/files/atom_ions.html
Site describes ions and characteristics associated with them.
P.S.-2.5

Energyquest.Ca.gov
http://www.energyquest.ca.gov/story/chapter13.html
Good description of both fusion and fission.
P.S.-2.6

Radiochemistry.org
http://www.radiochemistry.org/nuclearmedicine/radioisotopes/01_isotopes.shtml
General information on isotopes and medical applications in nuclear medicine.
P.S.-2.7

Suggested Literature

Miller, R. (2005). *The elements: What you really want to know*. N.Y., N.Y.: Lerner Publishing Group.
ISBN # 0-7613-2794-0
Historical account of how scientists studied the elements from the early Greeks to present day. Excellent source of information about each of the naturally occurring transuranium elements
P.S.-2.3

Menuing, T. M. (2004). *Isotopes: Principles and applications*. Hoboken, N.J.: John Wiley & Sons Inc.
ISBN # 0-471-38437-2
This book covers radiogenic, radioactive, and stable isotopes. This volume consists of five units that present fundamentals of atomic physics.
P.S.-2.2

Woodford, C. (2004). *Atoms and molecules*. N.Y., N.Y.: Thomson/Gale.
ISBN #1-41030-295-4
Describes the history of the scientific process by which atoms and molecules were discovered, looks at subsequent research into the structure and behavior of atoms and molecules, and includes information about people who contributed to the field.
P.S.-2.1, P.S.-2.4., and P.S.-2.5

Whiting, J. (2004). *Otto Hahn and the story of nuclear fission*. N.Y., N.Y.: Mitchell Lane Publishers.
ISBN # 1-58415-2044
Profiles German chemist Otto Hahn, whose research into radioactivity led to the discovery of nuclear fission and, despite his opposition, to the development of the atomic bomb.
P.S.-2.6 and P.S.-2.7

Cobb, C. (2002). *Magick, mayhem, and mavericks*. N.Y., N.Y.: Prometheus Books.
ISBN # 1-57392-976-X
This book depicts the story of the eccentrics who made groundbreaking discoveries in chemistry and physics. This book depicts how one idea is built upon another.
P.S.-2.1

Newton, D. (1994). *The chemical elements*. N.Y., N.Y.: Instructional Horizons.
ISBN # 0-531-12501-7
This volume gives broad general introductions to the chemical elements and the periodic table. The author of this book assumes no prior knowledge in chemistry.
P.S.-2.1, P.S.-2.3, P.S.-2.4, and P.S.-2.5

Stwertka, A. (2002). *A guide to the elements*. N.Y., N.Y.: Oxford University Press Inc.
ISBN # 0-19-515027-9
The history and properties of the elements are discussed as well as practical uses.
P.S.-2.1, P.S.-2.4, and P.S.-2.5

Mackintosh, R.& Khalili, A. & Johnson, B. & Pena, T. (2001). *Nucleus: A trip into the heart of matter*. Baltimore, M.D.: John Hopkins University Press.
ISBN # 0-8018-6860-2
This book depicts the history of the nucleus from discovery to the nuclear devices and nuclear medicine applications today.
P.S.-2..1, P.S.-2.6, and P.S.-2.7

Gallant, R. (2000). *The ever changing atom*. N.Y., N.Y.: Benchmark Books.
ISBN # 0-7614-0961-0
Matter to atoms to quarks all described in simple terms in this book. Additionally, this books covers isotopes, the splitting of the atom, and nuclear waste.
P.S.-2.1, P.S.-2.2, P.S.-2.4, P.S.-2.5, P.S.-2.6. and P.S.-2.7

Rigden, J. S. (2002). *Hydrogen: The essential element*. Cambridge, M.A.: Harvard College Press.
ISBN # 0-674-00738-7
This is the biography of Hydrogen. The book begins with the “Big Bang” and ends with questions of what we have left to discover about this element.
P.S.-2.1 and P.S.-2.6

Suggested StreamlineVideo Resources

Energy and the Chemistry of Life
Atoms and Elements
ETV Streamline SC
This clip goes into the structure of the atom and the subatomic particles
Atoms and Elements 3:33
P.S.-2.1

Elements of Physics: Matter: Atoms and Molecules
The Elements
ETV Streamline SC
This video describes protons, electrons, and neutrons. Atomic number and atomic mass are also covered.
The Elements 4:53
P.S.-2.1 and P.S.-2.4

Elements of Physics: Matter: Atoms and Molecules
The Periodic Table
ETV Streamline SC
This clip describes the trends in the periodic table.
The Periodic Table 2:49
P.S.-2.3

Elements of Physics: Energy: Work and Power
Nuclear Energy
ETV Streamline SC
This clip discusses fission and fusion and nuclear energy.
Nuclear Energy 1:10
P.S.-2.6

Elements of Chemistry: Atoms: The Building Blocks of Matter
The Structure of Atoms
ETV Streamline SC
This video discusses the structure of atoms along with a little history. Protons, electrons, and neutrons are covered.
The Structure of Atoms 2:20
P.S.-2.1

Elements of Chemistry: Atoms: The Building Blocks of Matter
Elements and Isotopes
ETV Streamline SC
This clip discusses atomic numbers and protons as well as differing neutrons and isotopes.
Elements and Isotopes 3:58
P.S.-2.2 and P.S.-2.4

Elements of Chemistry: Atoms: The Building Blocks of Matter
Ions
ETV Streamline SC
This video describes both negative and positive ions and the properties of each. This clip has excellent graphics.
Ions 1:48
P.S.-2.5

Physical Science: Nuclear Energy
The Curies and Nuclear Medicine
ETV Streamline SC
This clip depicts the history of the discovery of radioactive molecules and then delves into its uses in medicine.
The Curies and Nuclear Medicine 2:56
P.S.-2.7

Physical Science: Nuclear Energy
Nuclear Submarines
ETV Streamline SC
This clip discusses fission and how the U.S. powers a submarine with nuclear power.
Nuclear Submarines 3:04
P.S.-2.7

Simply Science: Periodic Table
Using the Modern Periodic Table
ETV Streamline SC
This clip has good descriptions of how to read a periodic table. Trends due to valence electrons are also discussed.
Using the Modern Periodic Table 6:24
P.S.-2.3 and P.S.-2.5

Career Connections

Chemical Engineer
Chemical engineers design chemical plant equipment and devise processes for manufacturing chemicals and products such as gasoline, synthetic rubber, plastics, cement, paper, and pulp. (P.S.-2.3 and P.S.-2.5)

Chemist
Chemists involved in research and development investigate the composition, structure and properties of substances, and the transformation these substances undergo. Chemists play an important role is such diverse areas as medicine, the environment, agriculture, and industry. (P.S.-2.3 and P.S.-2.5)

Nuclear Engineer
Nuclear engineers participate in broad areas of analysis, design, management, and research using nuclear energy for power plants, transportation, space exploration, diagnostic health, and environmental control of pollution. Some specialize in the development of nuclear weapons; others develop industrial and medical uses for radioactive materials. (P.S.2.6 and P.S.-2.7)

Nuclear Medical Technologist
Nuclear medical technologists are paramedical specialists who are concerned with the use of radioactive material for diagnostic and therapeutic purposes. They use radioactive material to perform body function studies and organ imaging to analyze biological specimens and to treat disease. Nuclear medical technologists are usually supervised by a Nuclear Medical Physician. (P.S.-2.7)

Radiation Therapist
Radiation therapists operate specialized radioactive equipment in order to treat diseases such as cancer. They not only help to administer the radiation to the patient, but also monitor and record the radiation's effect on the patient. (P.S.-2.7)